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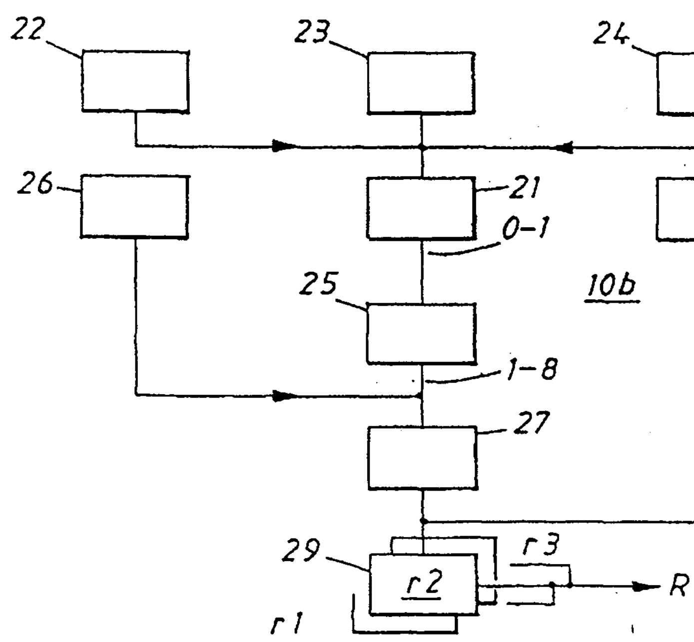
(54) Title: METHOD AND COMPUTER UNIT RELATED TO A PLANT

(57) Abstract



The invention relates to a method and a computer unit for enabling determination of a risk value for a plant, where the plant is provided with a preventive protective system, the protective system including one or more sensor units each of which is arranged to be able to determine the propensity of a risk-category-related risk source in the plant to cause damage in the plant, wherein a risk-source-related value for the probability of an incident is evaluated by co-ordinating a value for the probability of ignition, a value for the probability of inflammable material and/or a value for the probability of a breakdown situation. The value (21) for the probability of incident, applicable to a chosen risk source, shall be co-ordinated with plant-related data such as operative degree of exposure (26) to a chosen risk-category-related risk source in order to determine the risk frequency (27) of an event, and a value corresponding to the risk frequency is related to a value for the degree of gravity of the event, in order to enable determination of a risk value equivalent to the risk category and/or the risk source.

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METHOD AND COMPUTER UNIT RELATED TO A PLANT

Technical field

The present invention relates generally to a method related to a plant, and more particularly to a method for enabling determination of a relevant risk value for a process plant.

More specifically the method relates to enabling determination of a relevant risk value for e.g. insurance companies and for producers, where the total risk value thus obtained can be utilised to determine the insurance premium and/or risk taken by the producer.

The method is also suitable for application in plants provided with a preventive protective system, the protective system including at least one sensor unit, but more usually several sensor units, each pertaining to a risk category and adapted to a risk source.

The invention also relates to a computer unit adapted for operation in accordance with the method.

Each of these sensor units is arranged to be able to determine the propensity of a risk source in the plant to cause damage in the plant.

Damage of this type is primarily damage due to fire and explosions in equipment and process units, but also secondarily damage in the form of loss of production, quality problems, impaired reputation with customers and poorer reliability.

The invention may also be used to determine the total risk value of a closed area, such as machine rooms, airport buildings, cinema premises or other assembly halls.

In the following the invention will be exemplified primarily by application in a process plant provided with a preventive protective system.

Those skilled in this technical area are well aware of the additions and modifications required for adaptation of the invention to applications in technical areas other than that described here.

Background art

Several methods developed in order to more or less exactly determine a relevant total risk value for a plant are already known.

Currently known methods, however, can be deemed incomplete since each risk value determined is normally obtained by making various estimates in chosen calculations, where these estimates vary widely depending on the insight into the facts, of the person who is to determine the risk value.

Consequently, for one and the same method, the final result will be strongly dependent on the person's insight and experience.

For insurance companies it is unsatisfactory that to such an appreciable degree the total risk value and the probability of an incident occurring and an assessment of the extent of the incident, such as the EML value (Estimated Maximum Loss) for a break in production due to fire, that is so decisive for the insurance premium, shall be based solely on estimations.

It is also unsatisfactory and unacceptable for the policy holder or producer that to an appreciable degree the total risk value so decisive for the insurance premium and individual risk-taking, and also the probability of an incident occurring and an assessment of the scope of the incident, shall be based on estimates.

When assessing the magnitude of total risk values in this respect it is already known to work with specially defined expressions.

The concept of "risk" includes the probability of a specified circumstance (a risk source) resulting in a specified undesired event or effect over a given time period and where the following shall be taken into account as special circumstances; the probability of events occurring at all; the probability of an undesired consequence of an event and the magnitude of the consequence.

The concept of "risk management" covers measures for determining the risk and measures taken to reduce said risk, this being effected by: a risk identification; a risk selection; a risk analysis (where chosen risk categories and/or risk sources shall be studied from two aspects, namely exposure and effect); decisions concerning risk reduction; and choice of measure, the most usual methods being to analyse cost-effect and cost-benefit.

Thus methods are already known for determining an estimated total risk value for a process plant and reducing this risk value by providing the plant with a preventive protective system, which protective system generally includes a plurality of risk-category-related and/or risk-source-related sensor units, each of which is arranged to be able to determine the propensity of a risk source in the plant to cause damage in the plant.

Such known methods are based on allowing a risk-category-related value for the probability of an incident to be evaluated by co-ordinating an estimated value corresponding to the probability of an ignition, an estimated value corresponding to the probability of inflammable material and/or an estimated value corresponding to the probability of a breakdown situation.

It is normal to attempt to determine a value for the probabilities by studying previously known plants.

However, methods based on utilising values related to previously known process plants have been found to have serious deficiencies since process plants

of the type in question are different from each other, and since it has been found that even minor alterations in such process plants may produce considerable changes in the value for the probability, it is obvious that a risk value calculated on the basis of estimations will be far too uncertain.

Disclosure of the present invention

Technical problems

Considering the fact that the technical deliberations that must be performed by a person skilled in this technical area in order to arrive at a solution to one or more technical problems posed, entail both an initial insight into the measures and/or the sequence of measures to be taken, and also a choice of the means required and as a result thereof, the following technical problems are probably relevant in the development of the present invention.

In the light of the earlier state of the art, as described above, it must be deemed a technical problem to be able to provide a method and a computer unit offering a more exact and mathematical way of determining a relevant total risk value for a specific plant, such as a process plant of the type described in the introduction.

It is also a technical problem to be able, using simple measures, to determine the effect of a plant-related change on the total risk value calculated.

A technical problem is also involved in being able to realise the significance of, and the advantages associated with, supplementing a known method for determining a total risk value for a process plant with plant or system-related data, and subsequently performing a calculation of the risk value depending on the gravity of a chosen event. Criteria are thus created for compensating to a certain extent for any errors in the estimates on which a risk value has been calculated.

A technical problem is also involved in being able to realise the significance of, and the advantages associated with, having such a calculation performed for each of a number of chosen risk sources and thereafter calculating, by means of addition for instance, a total risk value for the plant.

A technical problem is then involved in being able to realise the significance of, and the advantages associated with, allowing a calculated value for the probability of an incident to constitute the basis for the criteria for a calculation of the risk value for a chosen risk category and a choice of a risk-category-related detector or sensor.

A technical problem is also involved in being able to realise the significance of allowing a value representative for said risk category to be co-ordinated with a value representative for how often a plant or a process section is exposed

to a risk (operative degree of exposure) in order to be able to determine a value therefrom for the risk frequency of an event.

A technical problem is also involved in being able to realise the significance of, and the advantages associated with, allowing said value for said risk category to be co-ordinated with, for instance multiplied by, a value representative for the degree of gravity of the event for each specific risk source, in order to be able to determine therefrom a risk-source-related or sensor-unit-related risk value.

A technical problem is also involved in being able to realise the significance of allowing a plurality of such sensor-unit-related risk values calculated in the same way to be co-ordinated, in order to be able to determine a final total risk value for the whole plant with increased accuracy.

A technical problem is also involved in being able to realise the significance of allowing the value representative of how often a process section is exposed to a risk to be evaluated by means of practical experience and/or operation of the plant or process section in question.

A technical problem is also involved in being able to realise the significance of, and the advantages associated with, allowing a value allocated to a risk amplitude for a risk category to be co-ordinated with, for instance multiplied by, a value representative of how often a plant or a process section is exposed to a specific risk source.

A technical problem is also involved in being able to realise the advantages of allowing a value representative of the gravity of the event be allocated a dimension of monetary value/risk amplitude and/or risk frequency per risk source.

A technical problem is also involved in being able, using simple measures, to create such criteria that, at a determined risk value for each of said risk categories and/or a total risk value calculated therefrom for the whole plant, and taking into account other values, a run-through can be performed in order to seek reasons enabling a reduction in the number of risk sources and/or their effect and/or a reduction in the risk elements, in order to create criteria to permit evaluation of a lower total risk value.

Solution

To solve one or more of the technical problems listed above, the present invention now takes as its point of departure a method and a computer unit enabling determination of a risk value for a plant where the plant is provided with a preventive protective system, the protective system including one or more sensor units each of which is arranged to be able to determine the propensity of the risk source of a risk category in a plant to cause damage in the plant, wherein a risk-category-related and/or risk-source-related value for the probability of an incident

is evaluated by co-ordinating a chosen number of estimated values such as the value for the probability of ignition, a value for the probability of inflammable material and/or a value for the probability of a breakdown situation.

The present invention particularly states that said value for the probability of incident, and applicable to a risk category and/or a risk source with a sensor unit adapted therefor, shall be co-ordinated with plant-related data such as operative degree of exposure to a chosen risk-category-related risk source in order to determined the risk frequency of an event, and that a value corresponding to the risk frequency is related to a value for the degree of gravity of the event, in order to determine a total risk value equivalent to the risk category and/or the risk source.

It is also stated, as proposed embodiments, that the total risk value shall be determined by co-ordinating a value for the risk frequency of the event with, for instance multiplying by, a value for the gravity of the event.

Said operative degree of exposure takes into account measured and/or calculated time distribution when and how a chosen risk category and/or risk source appears.

It is also stated that said value for the probability of incident for a risk category and/or risk source when using a sensor unit shall be co-ordinated with the chosen type of risk category to be detected and/or choice of detector or sensor, in order to determine a value therefrom that will be representative of the chosen risk category and the chosen risk source.

It is furthermore stated that said value for a chosen risk category and/or risk source shall be co-ordinated with a value representative of how often a plant or a process section is exposed to a risk category and/or risk source, in order to determine therefrom the value of the risk frequency of an event.

Said value for the risk frequency of the event shall be co-ordinated with, for instance multiplied by, a value representative of the degree of gravity of the event for each specific risk category and/or risk source, in order to be able to determine therefrom a risk-category-related risk value, and it shall be possible to co-ordinate a plurality of such risk values in order to determine said total risk value.

The value representative of how often a plant and/or a process section is exposed to a risk category, is evaluated by means of practical experience and/or by operation of a plant or a process section under normal conditions.

A value representative for a chosen type of risk category and/or risk source is evaluated in a computer unit.

A value for a chosen risk category that has been evaluated in a computer unit is co-ordinated with a value representative of how often a process section is exposed to a risk category.

A chosen value representative for the degree of gravity of the event is allocated a dimension of monetary value/risk frequency and/or risk amplitude.

A number of risk values obtained for a number of risk categories are coordinated in order to produce a total risk value.

In the case of one or more determined risk values and taking into consideration other values obtained, a run-through is performed to enable a reduction in the number of risk sources and/or their effect and/or a reduction in the risk elements, thereby enabling a lower risk value to be evaluated and determined.

Advantages

The advantages primarily associated with a method and a computer unit in accordance with the present invention are that criteria are created for determining a final and total risk value for a plant with greater precision than previously and this is achieved by introducing risk-category-, risk-source- and/or sensor-related values for various probabilities, thereby creating the potential for processing these values in such a way as to provide built-in compensation for one or more somewhat incorrectly estimated values relating to said probabilities.

The invention also offers the advantage of being able directly to evaluate the effect of continuous improvements.

What can be primarily deemed as characteristic for a method in accordance with the present invention is defined in the characterizing part of the appended claim 1.

Brief description of the drawings

An example of a process plant in which the method in accordance with the invention could be used, and a block diagram significant for enabling determination of a total risk value for a process plant, and also a computer unit, will now be described in more detail with reference to the accompanying drawings in which

Figure 1 shows schematically an example of a process plant in which the features of the invention can be utilised,

Figure 2 shows in block diagram form a method enabling determination of a process-plant-related risk value for a risk category and a risk source,

Figure 3 shows an embodiment by way of example of an operative degree of exposure for three risk categories, each with a risk source, over a period of one year, and

Figure 4 shows in block diagram form a computer unit with requisite memories and function blocks to enable determination of a total risk value from a plurality of risk-category-related values.

Description of a proposed embodiment

Figure 1 shows a plant A to which is connected a preventive protective system P, that can be used in a building, a process, an industrial process or process plant.

Application of the invention will be described in more detail, by way of example, with reference to a process plant in which a loosely formed material is produced in a first unit 1 and can be transported to a receiving unit 2 via a conveyor 3.

After processing, such as disintegration of paper pulp supplied via the arrow 4 to a mill 1, the material is now to be transported further via an outgoing pipe 5.

At this stage the processed material is in disintegrated form, such as cellulose fluff, and is transported by means of an air flow 6 via a pipe system 7, 8 and 9 forming part of the conveyor 3, to the second unit 2 in the form of a silo.

The exemplified disintegration of the paper pulp in the unit or mill 1 can create individual particles, one or more, (risk category and risk source) having a temperature sufficiently high to initiate a fire and/or explosion at least in the second part 2, but also in the conveyor 3.

Although the example describes the use of paper pulp to be disintegrated to fluff for transportation by an air flow to a silo, it is obvious that the inventive concept may be applied to other technical areas, for other purposes and particularly for other materials.

It is also shown here that all the disintegrated particles will be transported in the form of a loose material by a gas or gas mixture, usually air, placed under overpressure or vacuum.

There is nothing to prevent the loose material being transported in a gas or gas mixture by means of free fall in a shaft.

An additional requirement is that the treatment performed in the unit 1 is of such a nature that it could produce occasional particles, considered as a risk source, having a heat content or thermal energy that constitutes an incitement to fire or other damage in a pipe or a storage space, the "risk zone" 2.

It is here obvious that hot surfaces, flame or flames and the like could also be considered as risk sources.

The process plant illustrated in Figure 1 assumes that requisite transport of the loosely formed material, via system 3, occurring in the pipe 5 between said first unit 1 and said second unit 2 is allocated a stabilising zone 7, a zone 8 indicating an individual particle having said high temperature and an extinguishing zone 9, preceding said risk zone 2.

Initially a plurality of sensors 10, with one or more sensor units or sections 10a-10g exist within said indicating zone 8, said sensors being designed, for instance, as shown and described in more detail in Swedish patent application 98 04579-2 entitled "Detector arrangement".

Said sensor units 10a-10g may be oriented in one and the same plane across the pipe 8, or they may be suitably spaced from each other along the pipe.

It is obvious to one skilled in the art how the signal from several sensor units can be evaluated and how introduction of time factors can be effected in order to evaluate signals from sensor units situated some distance from each other, and this is therefore not discussed in detail.

A chosen number of sensor sections or units 10a-10g can be co-ordinated via a connection 11 with a unit 16 evaluating the output signal of each sensor section, connected to or forming part of an activating unit 12.

In the event of indication of too warm or hot particles, produced by a chosen number of sensors sections 10a-10g, the unit 12 will activate a device 15 pertaining to an extinguishing zone 9 that supplies extinguishing and/or particle-removing medium.

A number of other reference designations have been entered in Figure 1 and reference is made to the above-mentioned Swedish patent application for a deeper insight into the design of the process plant.

Said Swedish patent application could very well be considered as an example of the basic criteria necessary for the present invention.

A significant method according to the invention, and a computer system or unit for use with the method will now be described in more detail, particularly with reference to Figures 2 and 4.

The method and the construction of the computer unit are based on being able to determine a final or total risk value R for a complex plant, such as the process plant illustrated in Figure 1.

The process plant A is provided with a preventive protective system P, which protective system comprises a plurality of risk-category-related and risk-source-related sensor units 10a-10g, each of which is arranged to be able to determine the propensity of a risk-category-related risk source in the plant to cause damage in the plant.

To simplify understanding of the block diagram in Figure 2 for a chosen risk source, it should be observed that for the blocks illustrated the block:

22 shall state presumed conditions for the probability of ignition, and a selected percentage value may be relevant here;

23 shall state presumed conditions for the probability of the existence of inflammable material, and a selected percentage value may be relevant here;

24 shall state presumed conditions for the probability of the occurrence of a breakdown situation and, here too, a selected percentage value may be relevant;

In block 22 the risk of a critical amount of ignition energy being present in the plant or within a chosen process section is calculated by the computer unit or estimated.

In block 23 the risk of inflammable material being present is calculated by the computer unit or estimated.

In block 24 the risk of any chosen event being able to cause a breakdown situation is calculated by the computer unit or estimated.

On the basis of the presumed conditions in blocks 22, 23 and 24 a value can now be produced in block 21 by co-ordinating, for instance multiplying, the block-related percentage values, the value in block 21 then representing the probability of an incident.

This value will lie between 0 and 1, say for instance between 0.2 and 0.8.

The following explanation is perhaps required to facilitate understanding of the elements associated with the invention:

The term "risk category" refers to an evaluation and a selection of one or more of a plurality of categories that, individually or in combination with others, may result in a breakdown situation.

Examples of such risk categories may be: fire such as a flame or spark, heat such as a hot particle or glowing clump, the presence of gas and the like.

The term "risk source" refers to a circumstance falling within a risk category, that may result in a breakdown situation.

Examples of such a risk source may be: fire such as a flame or spark, etc. having a chosen energy content, an evaluation being performed as to whether the energy content exceeds or does not exceed a predetermined energy content and where a risk-source-related sensor unit is arranged to be able to sense the existence of the risk source and via a calculating unit determine its energy content. Energy contents exceeding the chosen value are considered as risk occasions that must be observed via risk-preventing measures whereas energy contents below the chosen value are considered as risk occasions not requiring direct measures.

The term "operative degree of exposure" shall be understood to mean a value that is representative of how many risk occasions the plant or process section is exposed to over a chosen time period, applicable to a risk category and

one or more risk sources, adapted for detection of various energy contents. This will be explained more fully with reference to Figure 3.

The term "risk frequency of an event" shall be understood to mean a value that is representative of and dependent on the value for the operative degree of exposure, the value for the probability of an incident, choice of risk category to be detected and choice of sensor or detector.

The term "risk value" shall be understood to mean the value that is representative for the risk frequency of an event co-ordinated with the degree of gravity of the event and applicable to a risk category and a chosen risk source.

The term "total risk value" shall be understood to mean the value that is representative of a plurality of risk values applicable to each of a plurality of chosen risk categories and risk sources, that has been co-ordinated via mathematical calculations in order to obtain a total risk value relevant to the plant or process.

The primary task of the invention is based on said values for the probability of an incident and applicable to a risk category being co-ordinated with plant-related data such as operative degree of exposure for a chosen risk category in order to determined the risk frequency of an event, and on a value corresponding to the risk frequency being related to a value for the degree of gravity of the event, in order to be able to determine a risk value equivalent to a chosen risk category.

The risk value shall be determined by co-ordinating a value for the risk frequency of the event with, for instance multiplying by, a value for the degree of gravity of the event.

Said operative degree of exposure takes into account measured and/or calculated time distribution of a chosen risk category and one or more chosen risk sources, say over a period of one year.

Referring to Figure 3 the conditions will now be described for obtaining a value, a computer-calculated value, from risk occasions to which the plant or process section is exposed over a chosen time period, such as one year.

Figure 3 is intended to illustrate the time distribution of risk occasions for three different risk categories, each having its own risk source, one of which senses glowing metal particles each having an energy content of predetermined value but below the total energy value for a breakdown situation.

Figure 3 shows the distribution of the risk occasions for the three different risk categories and the intensity during a time period lasting one year.

The first risk category relates to glowing metal particles, each having an energy level below the energy value for a breakdown situation.

To simplify matters it is presumed that each metal particle has the same energy content and that the existence of two adjacent particles will double the energy content.

It can also be presumed that if three such metal particles were to be co-ordinated within a short time interval they could give a total energy content exceeding the lowest energy value applicable for a breakdown situation.

Figure 3 is thus intended to illustrate that over a period of one year, one particle occurred during the second month and two adjacent particles occurred during the third month.

During the ninth month three adjacent particles occurred, which resulted in a stoppage and activation of devices 19, 20 or 21.

The second risk category and its sensor unit relates to the presence of gas. No risk occasion has been reported.

The third risk category and its sensor unit relates to the presence of flame. Three different risk occasions were noted during the year, each with a risk indication and/or an energy content causing a stoppage of the plant and activation of devices 19, 20 or 21.

Referring once more to Figure 2 it can be noted that different output signals are required from the unit 26 for the three different conditions stated above.

It can also be noted that calculation of the magnitude of the output signal to adequately represent the error distribution according to Figure 3 is complex, but that the invention is based on the assumption that, with the aid of relevant calculation norms, a risk-category-related and risk-source-related value can be obtained.

The value for the probability of an incident is evaluated in a block 21 by allowing an estimated value for the probability of ignition in a block 22 to be co-ordinated with an estimated value for the probability of inflammable material in a block 23 and/or an estimated value for the probability of a breakdown situation in a block 24.

A value shall thus be entered in block 22 that is representative for the risk of a critical amount of ignition energy being present in the process section, a value shall be entered in block 23 that represents a calculated risk of inflammable material being present, and a value shall be entered in block 24 that is representative for the risk of some event causing a breakdown situation.

The values for the blocks 22, 23, 24 are stated in % and the probability of an incident in block 21 is most easily determined by multiplying the values in blocks 22, 23 and 24 by each other.

Said value from block 21, usually between 0-1, e.g. 0.2-0.8, for the probability of an incident for a chosen risk category is co-ordinated with a value representing the type of risk source to be detected and/or a chosen value representing the actual choice of sensor or detector. These values are entered in block 25 so that a value representative of the risk category can be determined therefrom.

Said value for a risk category in block 25 is co-ordinated with a calculated value according to Figure 3, representative of how often a plant or a process section is exposed to a risk in a block 26, in order to determine therefrom the value of the risk frequency of an event in a block 27.

Said value for the risk frequency of the event is co-ordinated with, for instance multiplied by, a value representative of the degree of gravity of the event for the risk category in question and/or each specific risk source, this value being stored in a block 28, in order to be able to determine therefrom a risk-category-related risk value r2 in the block 29.

If only one risk category and one risk source are used, the risk value r2 will constitute the total risk value R.

The invention is based on a plurality of such risk-category-related and risk-source-related risk values r1, r2, r3 being co-ordinated, added for instance, in order to determine said total or final plant-related risk value R.

Admittedly Figure 2 illustrates that blocks 21-28 are used to calculate a risk value r2 for a risk category 10b, but Figure 2 shall also be considered to illustrate that corresponding blocks 21.28 can be used to determine a risk-category-related risk value r1 for a second sensor 10a or a risk-category-related risk value r3 for an additional sensor 10c, etc.

The value entered into the block 26 according to Figure 3 is representative of how often a process section will be exposed to a risk, and can be evaluated by means of practical experience and/or by normal operation of the plant or process section over a predetermined period.

A computer-related value representative of a chosen type of risk category and/or risk source in the block 25 is co-ordinated with, for instance multiplied by, a value representative of the choice of sensor or detector and, in the shown embodiment, may be assumed to give a value between 1 and 8.

The value for a chosen risk category is co-ordinated with, for instance multiplied by, a value representative of how often a plant and/or a process section is exposed to a risk, and the result is stored in block 27.

The value representative of the gravity of the event in block 28 is allocated a dimension of monetary value/risk frequency and/or risk amplitude. The consequences of each type of risk category and/or risk source are thus evaluated as a monetary value.

It is of course also possible within the frame of the invention in the case of determined value for a chosen risk category or risk source, and taking into consideration the magnitude and conditions prevailing upon obtaining other values, to perform a run-through in order to reduce as far as possible the number of risk

sources and/or reduce their effect and/or reduce the risk elements, thereby enabling a lower total plant-related risk value R to be evaluated.

As regards the values entered into blocks 22, 23 and 24 special consideration must naturally be taken as to whether the process plant P is transporting an excess of oxygen or contains particularly dangerous material with considerable risk of a particle having a critical quantity of ignition energy.

It can also be ascertained that at least the values in block 21, deriving from the values from blocks 22, 23 and 24, are estimated by a person qualified in the technical field.

The same can also be considered to apply to the monetary value entered in block 28. It may be noted here that different values can be stored, such as a value for complete reconstruction of buildings destroyed by fire, a value for total stoppage for one or more days, a value for lost customer contacts, a value for impaired reputation.

The values in blocks 25 and 26 will be dependent on investments made in the system whereas the actual co-ordination and calculation to obtain a total risk value takes place in blocks 27 and 29.

If only extremely prominent risk criteria with associated risk sources are evaluated in similar manner, and these are functionally separate from each other, it may be suitable to add the risk values r1, r2 and r3 in order to obtain a total risk value R.

If the risk criteria are functionally linked it may be suitable to have a more complicated calculation performed in order to reach a relevant total risk value R.

Such a total risk value R may then exceed or be below a total risk value R obtained by means of addition.

Figure 4 shows a computer unit 40 in block diagram form, with requisite memories and function blocks, illustrated as units, to enable determination of a total risk value R from a plurality, three, of risk-category-related values.

It is obvious that in the practical embodiment the number of risk-category-related and/or risk-source-related values may vary from one to a number considerably greater than three. However, this number has been chosen in order to explain the principles of the invention.

Estimated values relating to one or more data relating to chosen risk-category-related circumstances are entered into the computer unit 40 via the units and blocks 422a, 422b, 422c; 423a, 423b, 423c and 424a, 424b, 424c.

Each of these is linked to its own block or its own unit 421a, 421b and 421c so that the probability of an incident for each of the chosen risk categories can be evaluated therein.

Values representing the probability of an incident for each of the chosen risk categories are supplied to separate units 425a, 425b, 425c.

A value representative of the chosen detector or sensor is entered via units 425a', 425b' and 425c' to the respective units 425a, 425b and 425c, to enable chosen relevant risk sources within a chosen risk category to be evaluated and pin-pointed with the aid of this value.

A value is calculated via calculation units 430a, 430b and 430c which is dependent on output signals from the units 425a, 425b and 425c and the output signal from units 426a, 426b and 426c and is stored in the units 427a, 427b and 427c as the risk frequency of the event.

The output signals from units 427a, 427b and 427c are co-ordinated with the output signals from units 428a, 428b and 428c in respective units 431a, 431b and 431c to form individual risk values stored in the units 429a, 429b and 429c.

The output signal from each of the units 429a, 429b and 429c is co-ordinated in a calculating unit 432 to enable evaluation of the total risk value R.

A number of algorithms (functions) which must be available for a required calculation such as addition, mean value formation and the like, depending on chosen risk criteria and their relationship to each other, are stored in the unit 432 via a unit 433.

It shall be possible to evaluate the mutual relationship in a unit 434 for a suitable choice of a chosen algorithm.

Each of the units 426a, 426b and 426c is connected to respective units 435a, 435b and 435c, in which values represented by the result according to Figure 3 are entered so that calculation can be performed in units 426a, 426b and 426c in accordance with one or more of a plurality of stored algorithms (functions) to obtain a value that represents the result in question.

The value for each of the units 435a, 435b and 435c may also be entered as estimated values.

The invention is of course not limited to the embodiment described above by way of example. Several modifications are possible within the frame of the inventive concept illustrated in the appended claims.

CLAIMS

1. A method for enabling determination of a risk value for a plant, said plant being provided with a preventive protective system, the protective system including one or more sensor units each of which is arranged to enable determination of the propensity of a risk-category-related risk source in the plant to cause damage in the plant, wherein a risk-source-related value for the probability of an incident is evaluated by co-ordinating a value for the probability of ignition, a value for the probability of inflammable material and/or a value for the probability of a breakdown situation, **characterized** in that said value for the probability of incident, applicable to a chosen risk source, shall be co-ordinated with plant-related data such as operative degree of exposure to a chosen risk-category-related risk source in order to determined the risk frequency of an event and in that a value corresponding to the risk frequency is related to a value for the degree of gravity of the event, in order to be able to determine a risk value equivalent to the risk category and/or the risk source.

2. A method as claimed in claim 1, **characterized** in that the risk value shall be determined by co-ordinating a value for the risk frequency of the event with, for instance multiplying by, a value for the degree of gravity of the event.

3. A method as claimed in claim 1, **characterized** in that said operative degree of exposure takes into account measured and/or calculated time distribution when a chosen risk category and/or risk source appears.

4. A method as claimed in claim 1, **characterized** in that said value for the probability of incident for a sensor or a detector unit is co-ordinated with the chosen type of risk category to be detected and/or choice of detector, in order to determine therefrom a value that will be representative of the chosen risk category.

5. A method as claimed in claim 1, **characterized** in that said value for a chosen risk category is co-ordinated with a value representative of how often a plant or a process section is exposed to a risk category and/or risk source, in order to determine therefrom the value of the risk frequency of an event.

6. A method as claimed in claim 5, **characterized** in that said value for the risk frequency of the event is co-ordinated with, for instance multiplied by, a value representative of the degree of gravity of the event for each specific risk category and/or risk source, in order to be able to determine therefrom a risk-source-related

risk value, and in that a plurality of such risk-source-related risk values are co-ordinated in order to determine said total risk value.

7. A method as claimed in claim 1, **characterized** in that the value representative of how often a plant and/or a process section is exposed to a risk category, is evaluated by means of practical experience and/or by operation of a plant or a process section.

8. A method as claimed in claim 1, **characterized** in that a value representative of a chosen type of risk category and/or risk source is evaluated in a computer unit.

9. A method as claimed in claim 1, **characterized** in that a value for a chosen risk category that has been evaluated in a computer unit is co-ordinated with a value representative of how often a process section is exposed to a risk category.

10. A method as claimed in claim 1, **characterized** in that a chosen value representative for the degree of gravity of the event is allocated a dimension of monetary value/risk frequency and/or risk amplitude.

11. A method as claimed in claim 1, **characterized** in that a number of risk values for a number of risk categories are co-ordinated in order to produce a total risk value.

12. A method as claimed in claim 1, **characterized** in that in the case of one or more determined risk values and taking into consideration other values obtained, a run-through is performed in order to enable reduction of the number of risk sources and/or their effect and/or a reduction in the risk elements, thereby enabling a lower risk value to be evaluated and determined.

13. A computer unit adapted to enable determination of a risk value for a plant, where the plant is provided with a preventive protective system, the protective system including one or more sensor units each of which is arranged to be able to determine the propensity of a risk-category-related risk source in the plant to cause damage in the plant, wherein a risk-source-related value for the probability of an incident is evaluated by co-ordinating a value for the probability of ignition, a value for the probability of inflammable material and/or a value for the probability of a breakdown situation. **characterized** in that said value for the

probability of incident, and applicable to a chosen risk source, is co-ordinated with plant-related data such as operative degree of exposure for a chosen risk-category-related risk source in order to determine the risk frequency of an event, and in that a value corresponding to the risk frequency is related to a value for the degree of gravity of the event, in order to be able to determine a risk value equivalent to the risk category and/or the risk source.

14. A computer unit as claimed in claim 13, **characterized** in that the risk value is determined by co-ordinating a value for the risk frequency of the event with, for instance multiplying by, a value for the degree of gravity of the event.

15. A computer unit as claimed in claim 13, **characterized** in that said operative degree of exposure takes into account measured and/or calculated time distribution when a chosen risk category and/or risk source appears.

16. A computer unit as claimed in claim 14, **characterized** in that said value for the probability of incident for a sensor or a detector unit is co-ordinated with the chosen type of risk category to be detected and/or choice of detector, in order to determine therefrom a value that will be representative of the chosen risk category.

17. A computer unit as claimed in claim 13, **characterized** in that said value for a chosen risk category is co-ordinated with a value representative of how often a plant or a process section is exposed to a risk category and/or risk source, in order to determine therefrom the value of the risk frequency of an event.

18. A computer unit as claimed in claim 17, **characterized** in that said value for the risk frequency of the event is co-ordinated with, for instance multiplied by, a value representative of the degree of gravity of the event for each specific risk category and/or risk source, in order to be able to determine therefrom a risk-source-related risk value, and in that a plurality of such risk-source-related risk values are co-ordinated in order to determine said total risk value.

19. A computer unit as claimed in claim 13, **characterized** in that the value representative of how often a plant and/or a process section is exposed to a risk category, is evaluated by means of practical experience and/or by operation of a plant or a process section.

20. A computer unit as claimed in claim 13, **characterized** in that a value representative of a chosen type of risk category and/or risk source is evaluated in a calculating unit.

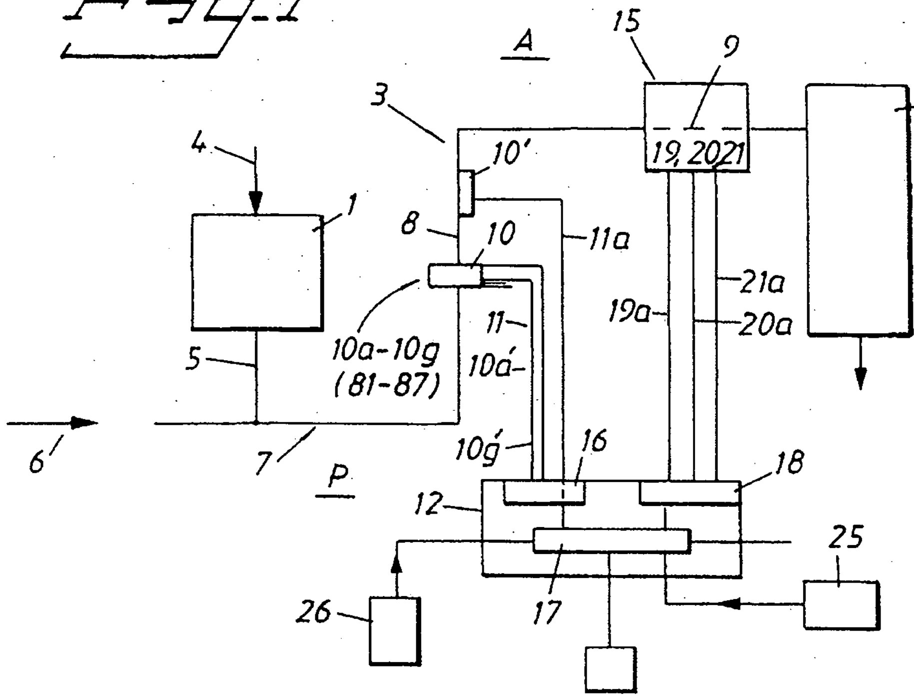
21. A computer unit as claimed in claim 13, **characterized** in that a value for a chosen risk category that has been evaluated in a calculating unit is co-ordinated with a value representative of how often a process section is exposed to a risk category.

22. A computer unit as claimed in claim 13, **characterized** in that a chosen value representative of the degree of gravity of the event is allocated a dimension of monetary value/risk frequency and/or risk amplitude.

23. A computer unit as claimed in claim 13, **characterized** in that a number of risk values for a number of risk categories are co-ordinated in order to produce a total risk value.

24. A computer unit as claimed in claim 13, **characterized** in that in the case of one or more determined risk values, and taking into consideration other values obtained, a computer-related run-through is performed in order to enable a reduction in the number of risk sources and/or their effect and/or a reduction in the risk elements, thereby enabling a lower risk value to be evaluated and determined.

Fig.1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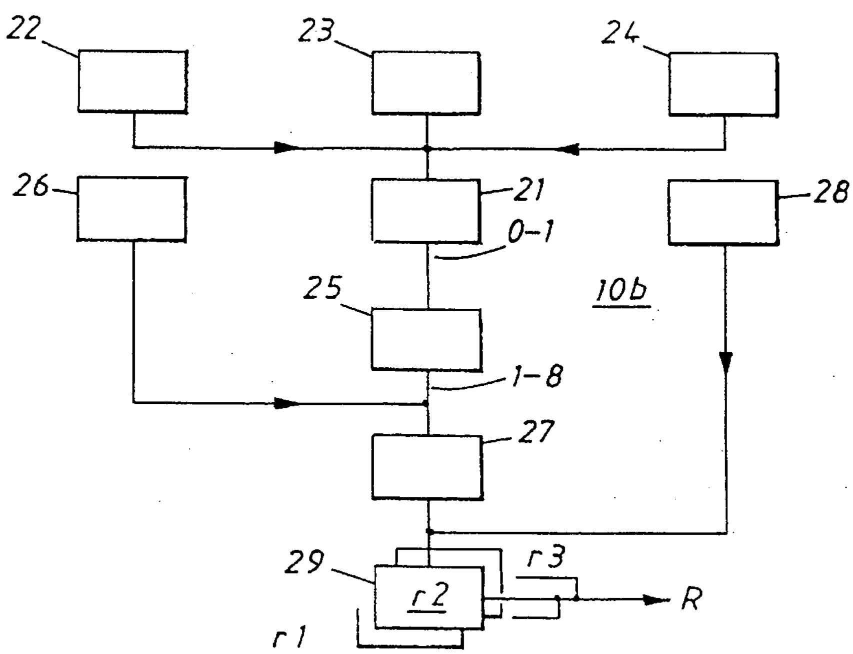
15
9
3
2
19, 20 21
4
10'
1
8
10
11a
21a
10a-10g
(81-87)
11
10a'
19a
20a
5
6
7
10g'
16
18
P
12
25
26
17

Fig.2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1-8
27
29
r3
r2
R
r1

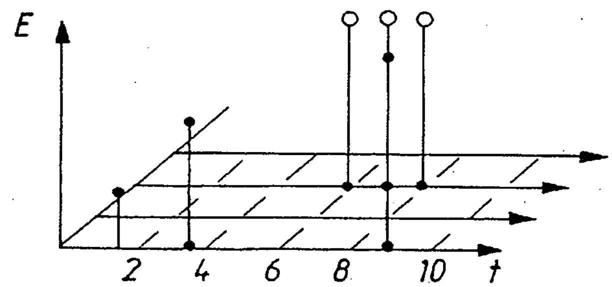
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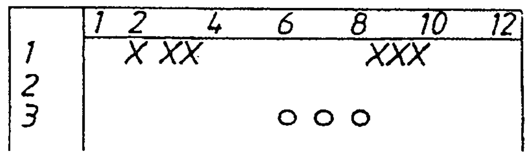
Fig. 3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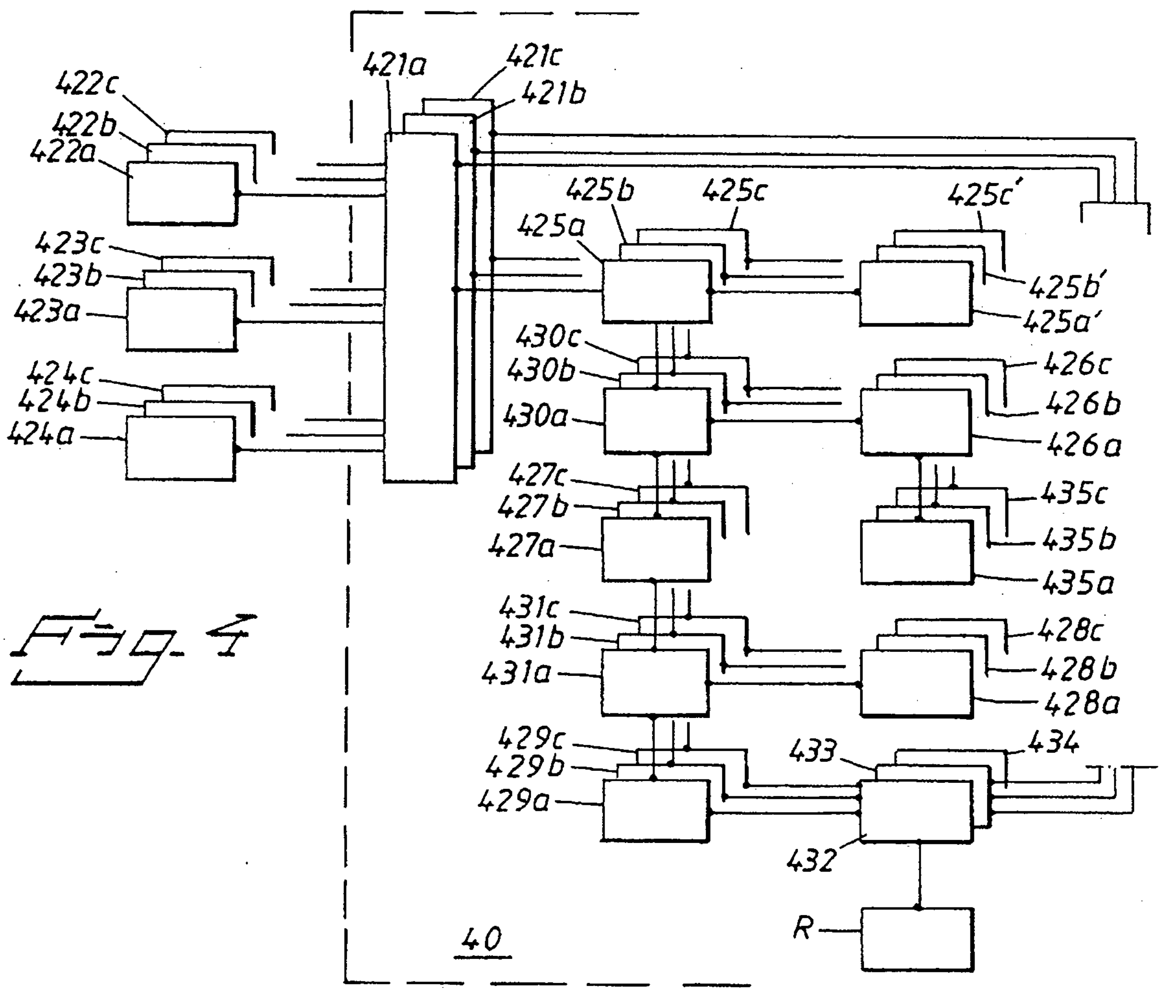
3 ○ ○ ○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425c
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425a
425b'
425a'
430c
430b
430a
426c
426b
426a
427c
427b
427a
435c
435b
435a
431c
431b
431a
428c
428b
428a
429c
429b
429a
433
434
432
R
40

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00939

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G06F 17/60

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstract of Japan, abstract of JP 9-114801 (NRI&NCC CO LTD) 2 May 1997 (02.05.1997) See page 1, line 1-14; figure 1 --	1-24
A	EP 0238681 A1 (BENKE INSTRUMENT & ELEKTRO AG), 30 Sept 1987 (30.09.87), See the whole document --	1-24
A	DD 223847 A (VEB BRAUNKOHLENVEREDLUNG), 19 June 1985 (19.06.85), See the whole document -- --------	1-24

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 August 2000	05 -09- 2000
Name and mailing address of the ISA Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jan Silfverling/LR Telephone No. +46 8 782 25 00

INTERNATIONAL-TYPE SEARCH REPORT

Search request No.
PCT/SE00/00939

Box I **Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international-type search report has not been established in respect of certain claims for the following reasons:

1. ☒ Claims No.: 1-12
because they relate to subject matter not required to be searched by this Authority, namely:
The subject matter of the invention, as described in claims 1-12, is considered a mathematical method. Thus, the invention as described in claims 1-12 is not a patentable invention, according to PCT rule 39. However, a search has been performed.

2. ☐ Claims No.:
because they relate to parts of the national application that do not comply with the prescribed requirements to such an extent that no meaningful international-type search can be carried out, specifically:

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international-type search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international-type search report covers only those claims for which fees were paid, specifically claims No.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international-type search report is restricted to the invention first mentioned in the claims; it is covered by claims No.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/12/99

International application No.
PCT/SE 00/00939

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0238681 A1	30/09/87	DE 8608112 U SG 72291 G	14/08/86 22/11/91
DD 223847 A	19/06/85	NONE	